Conducting Polymer Scaffolds Based On PEDOT:PSS/MXene Composites For Drug Delivery In Wound Healing Applications

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Abstract

This study presents the development of porous composite scaffolds composed of the conducting polymer PEDOT:PSS and the 2D material MXene, engineered for controlled drug delivery and antibacterial applications. Bacterial infections, especially those complicated by rising antibiotic resistance, pose a global health challenge, highlighting the need for materials that can deliver drugs while offering antibacterial properties. Conducting polymers (CPs) such as PEDOT:PSS exhibit electrical conductivity, biocompatibility, and the ability to form 3D biomimetic structures [1,2].
MXene, a two-dimensional material has emerged as a powerful candidate for biomedical applications. MXenes exhibit high conductivity, hydrophilicity, and antibacterial properties, including the ability to disrupt bacterial membranes and generate reactive oxygen species [3]. The scaffolds, fabricated via a freeze-drying method, were designed to investigate the relationship between composition and performance, particularly for controlled drug release and antibacterial efficacy. Tetracycline hydrochloride (TCH) was incorporated into the scaffolds as a model drug. Structural and electrochemical analyses revealed that increasing MXene content resulted in larger, more irregular pores and reduced conductivity, while PEDOT:PSS-dominated scaffolds exhibited smaller pores and enhanced conductivity. Drug release kinetics demonstrated slower, sustained release in scaffolds with higher MXene content, attributed to strong drug-material interactions. Antibacterial testing against Escherichia coli and Pseudomonas aeruginosa highlighted superior efficacy for MXene-rich scaffolds. These findings establish PEDOT:PSS/MXene composites as versatile platforms for drug delivery and antibacterial applications.

References

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[3] U. K. Rout, C. R. Sahoo, and D. Bhattacharya, “MXene-Based Materials for Antibacterial Activity,” in *MXenes*, 1st ed., Boca Raton: CRC Press, 2024.

Figures

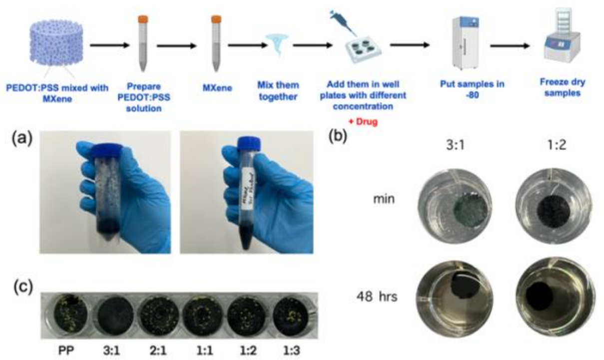

Figure 1: (Top) Preparation and characterization of PEDOT:PSS/MXene scaffolds. (a) PEDOT:PSS and MXene solutions. (b) Drug release at 0 and 48 h. (c) Drug loaded scaffolds with varying compositions.

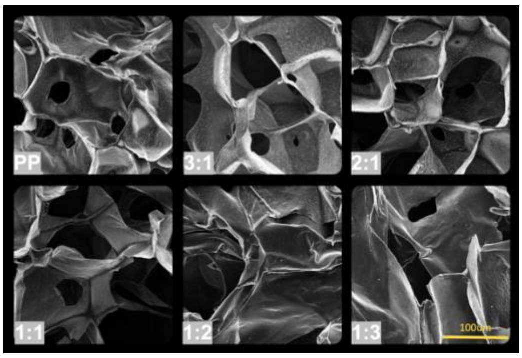

Figure 2: Bacterial growth inhibition of E. coli on different scaffold composites.